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To concentration of reproduction in cohorts of US and European women.

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Abstract
Concentration of reproduction designates the amount of inter-individual diversity among women in respect to number of children they have. It is measured by the concentration ratio, Havehalf and Halfhave statistics. Trends and inter-country differences in the concentration of reproduction for female cohorts with completed fertility are analyzed for the USA and 19 European countries. The decline described by prior studies has reversed first in the USA and then in Western and Eastern Europe. At present, concentration of reproduction tends to increase. This trend is predominantly determined by growing childlessness. Increases in shares of women with one child and decreases in numbers of women with two children produce additional effect in some countries. Concentration of reproduction is relatively high in West Germany, Anglo-Saxon countries and Finland and is low in most of the East European countries. Countries of Western and Southern Europe experience an intermediate level. Further analyses are based on the US survey micro-data. Education-race groups of American women experience a wide range of fertility regimes. Low average fertility and higher concentration of reproduction are found in advanced groups, least qualified groups experienced higher average fertility and lower concentration of reproduction. Childlessness depends on education mostly through time in partnership, while professional activity increases risk of childlessness in partnership. In spite of the large inter-groups differences, the general level of concentration of reproduction is mostly explained by inter-individual diversity within each group. Results suggest a growing division of labor among women reflecting their orientation toward family vs. work career. Future family policies should focus not only on majority of “working women”, but also addressing more specifically their preferences.

Introduction

Studies of fertility in the industrialized world have their prime focus on its declining *average* level and determinants of this trend (Bongaarts, 2002, UN Population Division, 2003, Morgan, 2003a, Caldwell and Schnidlmayr, 2003). Variability in fertility within population is used in an instrumental manner for linking intensity of birth to various explanatory variables by means of regressions. The present study focuses on the inter-individual diversity in fertility itself and considers it from a different perspective. This way of thinking about the amount of diversity in population is related to the concentration (or Lorenz) curve showing what proportion of women has what proportion of children. From this curve, one can see, for example, that 30 percent of the US women born in 1931-32 have half of children, while half of these women have 75 percent of children. At the same time, 62 percent of children were born to families with four or more children, while only 3 percent of children were born to families with one child. This way of looking at variability emphasizes what might be called a *division of labor*. It is interested in finding out how the general task of the population reproduction is shared among women of the same generation. The concentration of reproduction means that substantial inter-individual differences in fertility among women result in uneven distribution of the reproduction of offspring among them. The division of labor concept can be also expressed by an average inter-individual difference in "productivity" among women. It can be shown, for example, that the average difference in numbers of children between any pair of women of the US birth cohort born of 1931-32 is slightly higher than 1 child, which constitutes 0.32 of the average fertility of 3.2 children per woman.

Analysis of concentration of reproduction, based on the concentration curve, was pioneered by Vaupel and Goodwin in 1987. The study proposed so-called half-statistics for measuring the concentration of reproduction and also considered its variation across cohorts of the US women born from 1868 to 1931. Concentration of reproduction was high in cohorts of the beginning of 20th century due to high proportions of childless women combined with high proportions of women with many children. Concentration of reproduction declined across younger US cohorts.

Its highest values were observed in the US cohorts born around 1910 and the lowest value was observed in the cohort of 1931.

The present study re-visits the concentration of the population reproduction. It extends the pioneering works of the 1980s in four important respects. First, it gives a more detailed description of estimation and decomposition of concentration measures. Second, it examines more recent experiences of female cohorts born between the 1920s and the early 1960s. Third, it analyzes a variety of national fertility patterns including European countries and the USA. Fourth, it tries to link the US pattern of concentration of reproduction with several socio-demographic factors using survey micro-data.

1. Data and methods of measurement.

There are two principal sources of data allowing to estimate distributions of women by number of children they have. First, these are surveys and censuses with reproductive history questions. Quality of distributions of women by number of children, obtained from tabulations of these data, depends on the quality of answers to retrospective questions and also on potentially biasing effects of differential migration and mortality acting in female population between the time of birth and the time of interviewing.

The same distributions can be derived from statistical data on fertility by birth order and age of mother. Unfortunately, these data are not readily available in many countries. In some countries the definition of birth order is restricted to marital births only or to births in current marriage only. This is the case in the three largest Western European countries: Germany, France and the UK. Characteristics of cohort fertility for these countries were estimated only recently thanks to studies combining survey information with statistical data on births (Birg et al., 1990, Kreynfeld, 2002, Toulemon and Mazuy, 2001, Toulemon, 2001, Handcock et al., 2000, Smallwood, 2002).

Since the 1980s the Observatoire Démographique Européen (ODE) research group has been developing methods and software for estimation of consistent demographic series across European countries (ODE, 2000, Sardon, 2002, Frejka and Sardon, 2003). For analysis of trends, we use the special collection of data on cohort fertility by age of mother and parity in 13 European countries produced by the ODE for the Max Planck Institute for Demographic Research in 2001-2003 (hereafter called the ODE data collection). These data include country-sets of age- and parity-specific fertility rates for birth cohorts in a uniform format calculated from the original fertility data of various shapes. In each country-set the age of mother varies from15 to 49 years and the birth order varies from 1 to 5+.

In addition, we use the equivalent data from Russia, Sweden, and the USA. The US data originate from the Heuser's series of fertility tables (Heuser, 1976), which has been computerized and updated for younger cohorts by W.Kingkade. The Russian cohort fertility data have been calculated by us from the original Goskomstat's tables on births by parity and age of mother. Finally, the Swedish fertility data have been extracted from the Swedish population registers made available to us by Statistics Sweden. Foreign-born women are not considered due to possible underreporting of births given before the move to Sweden. Table 1 reviews fertility series for countries, for which at least 15 female cohorts are available.

Table 1. Series of cohort fertility by parity and age of mother for 12 countries with 15 or more women's birth cohorts available.

Country	First cohort	Last cohort	Number of cohorts	Calendar years covered
Bulgaria	1931-1932	1962-1963	32	1947-2002
Czech Republic	1934-1935	1961-1962	28	1950-2001
England and Wales	1921-1922	1955-1956	35	1937-1995
Greece	1944-1945	1959-1960	16	1960-1999
Hungary	1936-1937	1961-1962	26	1952-2001
Ireland	1944-1945	1961-1962	18	1960-2001
Italy	1936-1937	1957-1958	22	1952-1997
Russia	1930-1931	1958-1959	29	1946-1998
Slovakia	1934-1935	1961-1962	28	1950-2001
Slovenia	1934-1935	1961-1962	28	1950-2001
Sweden	1925	1962	37	1941-2002
USA	1921-1922	1960-1961	40	1937-2000

Sources: For all countries except Russia, Sweden, and the USA – the ODE (2003) data collection. For Russia - the original Goskomstat's statistical tables. For Sweden - extract from the Swedish population registers. For the USA - the Heuser (1976) fertility series updated by W.Kingkade.

For a cross-country comparison of the last available cohorts with completed fertility, we use seven more countries. These are Finland, Romania, and Spain (data from ODE, 2003), the Netherlands and Norway (the Eurostat/New Cronos (2002) database), France (data by Toulemon (2001)) and West Germany (data by Kreynfeld (2002)). We use Swedish fertility data for the female cohort of 1960 from the Eurostat/New Cronos (2002) database instead of the register data since the former data cover both native- and foreign-born women as it is in the comparator countries.

For every country and birth cohort we first calculate the parity progression table from a matrix of age- and parity-specific birth rates $f_{x,i}$. Methods for building these tables have been developed elsewhere (Chiang and Van Den Berg, 1982, Lutz, 1989, Feeney, 1991, Andreev and Barkalov, 1999, Kohler and Ortega, 2002). Appendix 1 describes a concrete calculation procedure used in this study.

In addition to conventional fertility variables such as average completed fertility (*CF*) and average age of mother, the procedure returns tabular numbers of women and numbers of children born by by age and parity ($l_{x,i}$ and $C_{x,i}$, respectively). Proportions of women having *i* or less children ($PW_{x,i}$) and proportions of children born by these women ($PC_{x,i}$) are calculated as

$$PW_{x,i} = \sum_{j=0}^{i} l_{x,j} / \sum_{j=0}^{I} l_{x,j} \ .$$

$$PC_{x,i} = \sum_{j=0}^{i} C_{x,j} / \sum_{j=0}^{I} C_{x,j} \ .$$

The concentration curve expresses the relationship between $PC_{x,i}$ and $PW_{x,i}$. It presents cumulative share of children as a function of cumulative share of women. If the population share is always equal to the share of children, there is a situation of perfect equality and the concentration curve is simply the diagonal (Figure 1). Greater the amount of diversity/variability in population greater the deviation between the concentration curve and the diagonal.

Figure 1 presents an example of the concentration curve for a cohort of the US women born in 1950-51. *Havehalf* and *Halfhave* are the two measures of concentration of reproduction used in the prior studies (Goodwin and Vaupel, 1985, Vaupel and Goodwin, 1987). *Havehalf* is defined as a minimum proportion of women having half of all children (Figure 1). *Halfhave* is defined as a maximum proportion of children born by a half of all women. *Havehalf* decreases and *Halfhave* increases as the amount of diversity increases.

According to the geometrical definition, the concentration ratio (*CR*) is the area between the concentration curve and the diagonal divided by the whole area above the diagonal (equal to 1/2). There are several other ways to define the concentration ratio (called also Gini coefficient). All of them are equivalent (Anand, 1983). The definition by Kendall and Stuart (1966) is especially helpful for understanding the nature of this measure. It states that *CR* is simply a mean of absolute inter-individual differences in numbers of children relative to the overall average number of children (for more details and examples see Anand et al., 2001, Shkolnikov et al., 2003). In terms of the division of labor in the population's reproduction, *CR* is an average inter-individual difference in productivity relative to the mean productivity.

Figure 1 reveals a significant concentration of fertility in the 1950-51 US cohort with only 1/4 of women having half of children, half of women having 3/4 of children, and with mean inter-individual difference in numbers of children constituting 0.35 of the average number of children.

All the three concentration measures are meaningful and intuitively transparent. They are also easy to calculate from $PC_{x,i}$ and $PW_{x,i}$. *CR* on one side and *Havehalf*, *Halfhave* on the other side measure the amount of diversity in somewhat different ways and have somewhat different formal properties. In particular, the half-statistics, as percentile-type measures, have a disadvantage of being insensitive to certain re-distributions. Indeed, the half- cutting points on the concentration curve would be the same in spite of any re-distributions taking place either below or above these cut-points. In Figure 1, proportion of women with no children is 16 percent and proportion of women with one child is 12 percent constituting together 28 percent of all women. Corresponding value of *Halfhave* is about 75 percent. It will remain the same if 20 percent of women would have no children and 8 percent of women have one child. This is a disadvantage because the latter situation is clearly less equitable compared to the former situation. Thus, *CR* has a theoretical advantage since it has been proved to be sensitive to any increase of inter-individual distances (Anand, 1983).

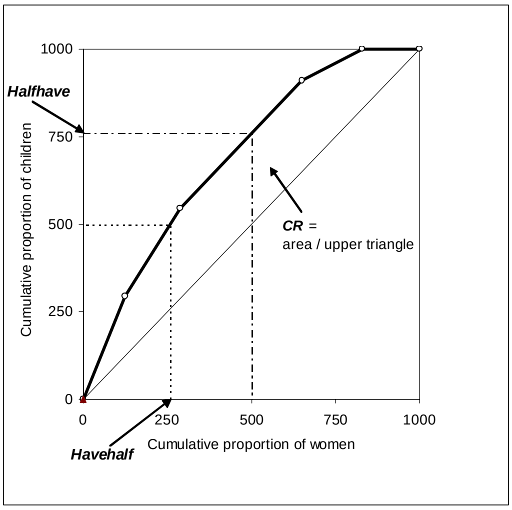

Figure 1. Concentration (or Lorenz) curve for the US female cohort born in 1950-51 and the three concentration measures.

Source: calculations from data by Heuser (1976) updated by W.Kingkade.

In practice, however, there is a high correlation between the three measures. For the whole set of countries and birth cohorts under consideration (Table 1), the Pirson's correlation coefficients between the measures vary from 0.93 to 0.97 (analysis not shown here). Although in some cases *Halfhave* and *Havehalf* are less sensitive, compared to *CR*, to re-distributions of fertility by parity, overall trends are very similar independently from a choice of measure.

In all female cohorts under consideration fertility is very low at ages over 40. Appendix 2 presents a comparison between values of *CF*, average age of mothers, and the concentration measures computed for the range of ages from 15 to 39 with the equivalent values computed for the range of ages from 15 to 44. The differences are very small. This gives an opportunity to operate with the narrower range of ages and, correspondingly, to consider a few more younger female cohorts up to the ones born in the early 1960s.

The empirical analyses presented in this paper show that childlessness makes an especially important contribution to temporal change of the concentration of reproduction. Therefore, it is useful to distinguish between two parts of diversity: diversity due to proportion of childless and diversity due to variability in number of children among mothers.

Havehalf and *CR* for mothers can be connected with *Havehalf* and *CR* for all women in a simple way:

$$Havehalf^{M} = Havehalf / a_1 ,$$

$$CR^{M} = 1-(1-CR)/a_1 ,$$

where a_1 is a probability of having at least one child (progression ratio to parity 1 = 1-proportion of childless).

The back transformations are:

$$Havehalf = Havehalf^{M} \cdot a_1$$

$$CR = 1-(1-CR^{M}) \cdot a_1 .$$

Consequently, a difference between *CR*s of two female cohorts 1 and 2 can be decomposed into contribution of the difference in variability among mothers and contribution of the difference in proportions of childless:

$$^{1}Havehalf - {}^{2}Havehalf = ({}^{1}Havehalf^{M} - {}^{2}Havehalf^{M})\frac{({}^{1}a_1 + {}^{2}a_1)}{2} + ({}^{1}a_1 - {}^{2}a_1)(\frac{{}^{1}Havehalf^{M} + {}^{2}Havehalf^{M}}{2}) ,$$

$$^{1}CR - {}^{2}CR = ({}^{1}CR^{M} - {}^{2}CR^{M})\frac{({}^{1}a_1 + {}^{2}a_1)}{2} + ({}^{1}a_1 - {}^{2}a_1)(\frac{{}^{1}CR^{M} + {}^{2}CR^{M}}{2} - 1) .$$

More detailed decompositions by every parity or every parity and age of mother can be accomplished by using the general algorithm of stepwise replacement (Andreev et al., 2002).

2. Trends in concentration of reproduction.

Figure 2 presents trends in the average fertility of cohorts for five western and five eastern countries with relatively long statistical series available.

The left panel shows marked changes in completed fertility across birth cohorts in five western countries. The average fertility increases from cohorts of the early 1920s to the cohorts of the mid-1930s in the USA and England and Wales due to the baby boom (Macunovich, 2002, Morgan, 2003b) and then decreases to about 2 children per woman in cohorts of the 1950s and the early 1960s. In the USA the magnitude of changes is much greater than that in England and Wales. Average completed fertility also decreases from older to younger cohorts in Italy down to 1.7 children per women in the 1957-58 cohort. In Sweden directions and timing of temporal changes are similar to those in England and Wales, but the magnitude of variation is much smaller. Average completed fertility was about 1.9 in the cohort of 1925, 2.1 in the cohorts of the mid-1930s, and 1.9-1.95 in cohorts of the late 1940s, the 1950s and the early 1960s. Finally, Ireland experiences a late fertility transition expressing itself in a steep decrease in average fertility from 3.2 children per woman in the 1946-47 cohort to 2.3 children per woman in the 1961-62 cohort.

Compared to unequivocal changes in western countries (except Sweden), the group of Eastern European countries experiences only relatively small temporal variations in average fertility in a narrow corridor between 1.8 and 2.1 children per woman (Figure 2, lower panel). Average fertility trend is somewhat more variable in Russia, where cohorts born during World War 2 and just after experience lower fertility than the older and the younger cohorts.

In general, western countries represent a variety of fertility trends with a predominant general decline in average fertility over cohorts of the 1940s-1950s (the 1930s-early 1950s in the USA) followed by stabilization in the USA and Finland. Eastern European countries exhibit a long-standing pattern of stable fertility in cohorts of the 1930s - the early 1950s followed by declines in younger cohorts in Bulgaria, Slovenia, and the Czech Republic and some increase in Hungary.

Upper panel of Figure 3a shows that the decline in the concentration of reproduction, described by Vaupel and Goodwin (1987), for the US cohorts born between the beginning of the 20th century and the 1930s, has reversed. This change indicates growing inter-individual variability around a lower average fertility.

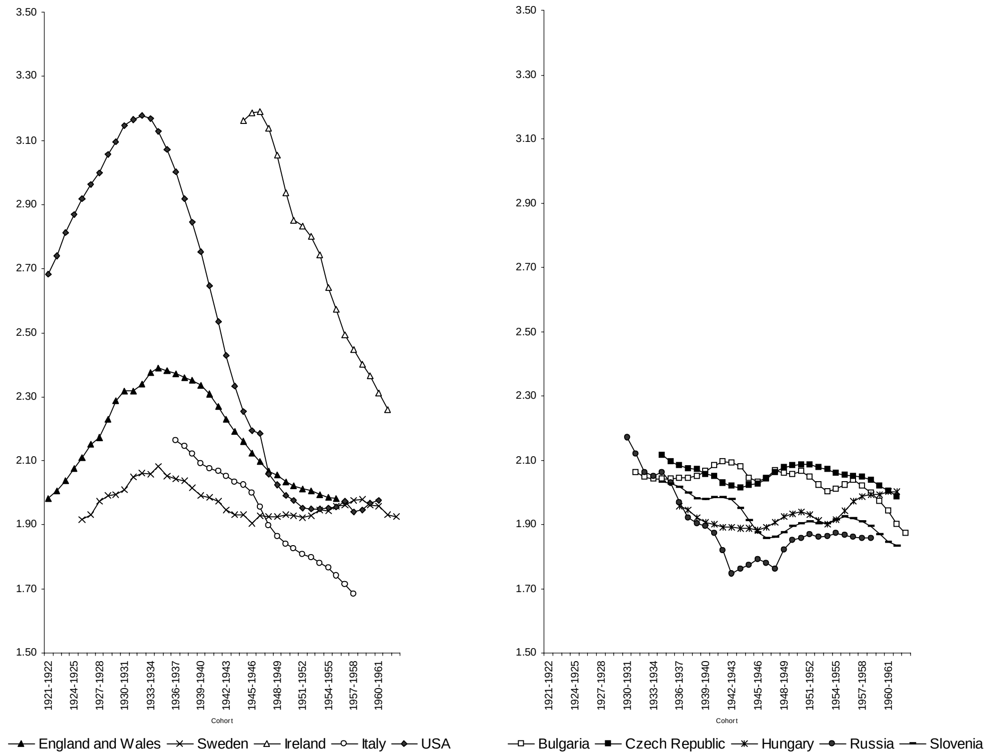

Figure 2. Completed fertility in five western and five eastern countries in cohorts born between 1921-22 and 1962-63.

Sources: For European countries except Sweden: calculations from ODE (2003) data collection. For Sweden calculations from data exctracted from the Swedish population register. For the USA: calculations from fertility series by Heuser (1976) updated by W.Kingkade. For Russia: calculations from the original Goskomstat's statistical tables.

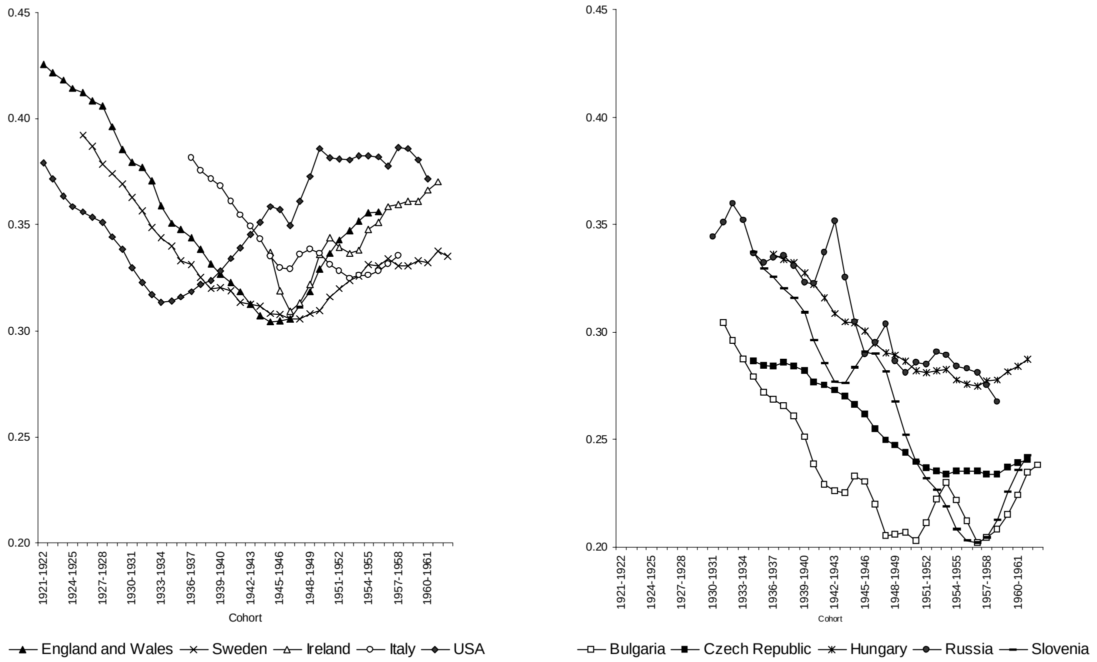

Figure 3a. Concentration ratio in five western and five eastern countries in cohorts born between 1921-22 and 1962-63.

Sources: For European countries except Sweden: calculations from ODE (2003) data. For Sweden: calculations from data exctracted from the Swedish population register. For the USA: calculations from fertility series by Heuser (1976) updated by W.Kingkade. For Russia: calculations from the original Goskomstat's statistical tables.

In the USA the value of *CR* increased from 0.33 in the 1933-34 cohort to 0.39 in the 1958-59 cohort and then slightly decreased. In England and Wales *CR* increased from 0.30 in the 1944-45 cohort to 0.36 in the 1955-56 cohort. Correspondingly, proportions of women having half of children (*Havehalfs*) decreased from 0.30 to 0.26 in the USA[1] and from 0.30 to 0.28 in England and Wales. In Sweden the increase was less pronounced: from 0.31 in the cohort of 1944 to 0.34 in the cohort of 1962. Across cohorts born after the late 1940s, *CR* increased in Ireland and was stable in Italy. In the USA, values of *CR* and half-measures in the youngest cohorts are the same as in the cohorts of the 1920s, which experienced much higher levels of average fertility. This is not the case for two other countries with long time series, England and Wales and Sweden, where endpoints of the *CR* trends lie substantially below their starting points.
A similar upturn, though a later and a less pronounced one, can be found also in Eastern European countries, where concentration of reproduction begins to level off or increase in cohorts of the second half of the 1950s and the early 1960s (Figure 3a, right panel). One can note also short-term elevations of *CR* in Russia and Slovenia for cohorts born around 1942 and 1945, respectively.

Figure 3a suggests also that the concentration of reproduction is generally higher in the West than that in the East. In the most recent cohorts *CR*s vary among the Eastern European countries from 0.23 in Bulgaria to 0.29 in Hungary, while in the group of western countries *CR*s vary from 0.34 in Italy to 0.37 in the USA and Ireland.

Figures 2 and 3a together suggest that in western countries a general decline in the average fertility, beginning from cohorts of the 1940s (cohorts of the early 1930s for the USA), coincided with increases in the concentration of reproduction. Remarkably, in the USA and Sweden average completed fertility was rather stable across 5-7 youngest cohorts of the 1950s and the early 1960s, while *CR*s tended to increase. For sequences of cohorts, Eastern European countries represented a different pattern with a stable average level of fertility combined with lowering concentration of

[1]The trend for the USA in Figure 3a agrees with the Gini coefficient trend in figure 2 in study by Lichter and Wooton (2003).

reproduction. However, in some countries this pattern has started to change in the youngest cohorts towards a higher concentration of reproduction.

3. Temporal changes in the concentration of reproduction and the role of childlessness.

For all countries under consideration, trends in *CR* in Figure 3a can be divided into two phases: the phase of decrease across the older cohorts and the phase of increase or leveling off across the younger ones. Generally the decrease in *CR* during the first phase was due to reduction of childlessness, lowering proportions of women with three and 4+ children, and an increase in proportions of women with two children. Consequently, the central part of distribution of women by number of children was becoming heavier, while its branches were becoming lighter.

The second phase of *CR* increase or stabilization begins from cohorts born in the early 1930s in the USA, from cohorts born in the second half of the 1940s in Western Europe, and from cohorts born in the mid-1950s in Eastern Europe. Table 2 shows changes in proportion of childless, average completed fertility, and the three measures of the concentration of reproduction for all women and for mothers in the USA, England and Wales, Sweden, Bulgaria, and Italy. In all these countries *CR* increases between the cohorts of 1941-42 and the last cohorts of the late 1950s-early 1960s. In spite of some increase, Bulgarian *CR* remains very low even after some increase.

Table 2. Proportion of childless women, average completed fertility and three measures of concentration of reproduction for all women and for mothers in the USA, England and Wales, Finland, Bulgaria, and Italy: cohorts born between the 1920s and the 1960s.

	Childless-ness	*CF*	*CR*	*CR* for mothers	*Havehalf*	*Havehalf* for mothers	*Halfhave*	*Halfhave* for mothers
USA								
1921-1922	0.12	2.68	0.38	0.29	0.25	0.29	0.78	0.73
1931-1932	0.09	3.17	0.32	0.25	0.30	0.33	0.75	0.70
1941-1942	0.11	2.54	0.34	0.26	0.28	0.32	0.74	0.69
1951-1952	0.17	1.95	0.38	0.25	0.26	0.32	0.76	0.67
1960-1961	0.16	1.98	0.37	0.25	0.27	0.32	0.75	0.67
England and Wales								
1921-1922	0.18	1.98	0.43	0.30	0.24	0.29	0.80	0.70
1931-1932	0.13	2.32	0.38	0.28	0.26	0.30	0.76	0.70
1941-1942	0.10	2.27	0.32	0.24	0.30	0.33	0.71	0.67
1951-1952	0.16	2.01	0.34	0.22	0.28	0.34	0.72	0.64
1955-1956	0.18	1.98	0.36	0.22	0.28	0.36	0.74	0.63
Sweden								
1925	0.17	1.92	0.39	0.27	0.26	0.31	0.77	0.68
1931	0.14	2.05	0.35	0.25	0.28	0.32	0.74	0.67
1941	0.13	1.97	0.31	0.21	0.30	0.34	0.70	0.64
1951	0.14	1.92	0.32	0.21	0.30	0.35	0.71	0.64
1962	0.17	1.92	0.34	0.20	0.29	0.35	0.72	0.63
Bulgaria								
1931-1932	0.08	206	0.30	0.24	0.31	0.33	0.69	0.65
1941-1942	0.03	2.10	0.23	0.21	0.36	0.36	0.64	0.63
1951-1952	0.03	2.05	0.21	0.19	0.37	0.38	0.63	0.61
1961-1962	0.06	1.90	0.24	0.20	0.36	0.38	0.65	0.62
Italy								
1936-1937	0.16	2.16	0.38	0.26	0.26	0.31	0.76	0.68
1941-1942	0.14	2.07	0.36	0.26	0.28	0.32	0.73	0.66
1951-1952	0.13	1.81	0.33	0.22	0.30	0.35	0.72	0.65
1957-1958	0.15	1.68	0.34	0.22	0.31	0.36	0.73	0.64

Sources: For European countries except Sweden: calculations from ODE (2003) data. For Sweden: calculations from data exctracted from the Swedish population register.

For the USA: calculations from fertility series by Heuser (1976) assembled and updated by W.Kingkade.
For Russia: authors' calculations from the original Goskomstat's statistical tables.

Figure 3b shows trends in *CR* for mothers for the same selection of countries as in Figure 3a. Comparison of the two figures reveals differences between *CR* trends with included and excluded impact of childlessness. First of all, trends in Figure 3b are flatter and the second-phase increases in *CR*s, seen in Figure 3a, correspond to leveling off or even small decreases in *CR*s for mothers in Figure 3b. Among western countries (upper panel), only England and Wales experience some increase in *CR* for mothers across the last seven cohorts. Among Eastern European countries (lower panel) only Hungary experiences an increase in *CR* for mothers, while there is no increase in Bulgaria and Slovenia.

Finally, the short-term fluctuations in *CR*s of cohorts of the 1940s in Russia and Slovenia, seen in Figure 3a, are not present in Figure 3b. It means that these effects are induced by relatively high childlessness in cohorts born during or immediately after World War 2 in the two counties.

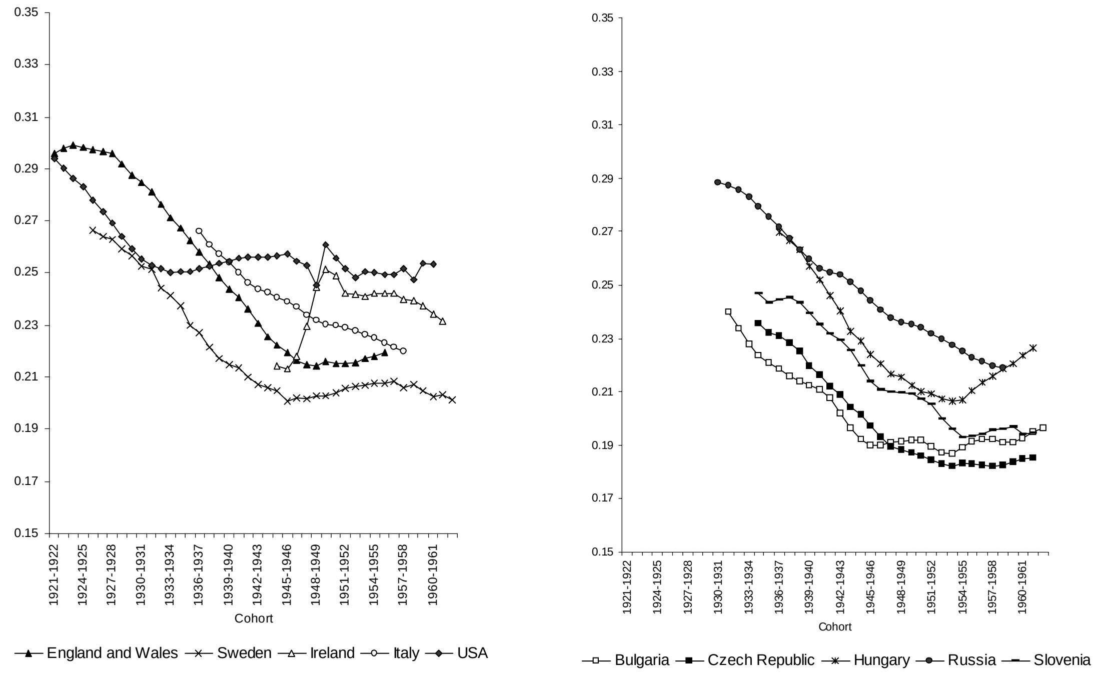

Figure 3b. Concentration ratio for mothers in five western and five eastern countries across cohorts born between 1921-22 and 1962-63.

Sources: For European countries except Sweden: calculations from the ODE (2003) data. For Sweden: calculations from data exctracted from the Swedish population registers. For the USA: calculations from fertility series by Heuser (1976) updated by W.Kingkade. For Russia: calculations from the original Goskomstat's statistical tables.

A 10-year sequence of cohorts born between the early 1950s and the early 1960s (the late 1950s for some countries) cohort fertility data are available for 14 countries (Table 3). In eleven of them *CR* has increased from the first to the last cohort. *CR* has somewhat decreased only in Russia, the USA, and Greece.

Effects produced by temporal changes in proportions of women with different numbers of children can be measured directly by decomposing changes in *CR* by parity (see section 1). Table 3 shows results of the decomposition. In England and Wales, for example, *CR* increases by 0.019 from the cohort of 1951-52 to the cohort of 1961-62. This increment results from summing up the following parity-components: +0.024 dur to increase in childlessness; -0.009 due to decrease in proportion of women with one child, +0.003 due to decrease in proportion of women with 2 children, and +0.001 due to increase in proportion of women with 3+ children. In Ireland, Italy, Sweden, Denmark, Greece, and Bulgaria growing childlessness produced the greates contributions to increases in *CR*s.

In the USA *CR* slightly decreased between cohorts of 1950-51 and 1960-61 due to small decreases in proportions of women with no children and with one child.

In Romania, Bulgaria, Greece, and Italy increasing proportions of women with one child produced additional positive contributions to *CR*. These were combined with lowering proportions of women with two and 3+ children. In Russia, Czech Republic, and Slovakia proportions of women with one child increased and produced positive contributions to *CR*, while proportions of childless women did not influence *CR*. Finally, in Hungary proportion of women with no children and with two children somewhat decreased, while proportions of women with one child and 3+ children increased leading to a small increase in *CR*.

Table 3. Changes in the concentration ratio between cohorts of the early 1950s and cohorts of the early 1960s and their components by parity in 14 countries.

	Cohort1	Cohort 2	*CR*1	*CR*2	Difference	Components			
						0	1	2	3+
USA	1950-51	1960-61	0.382	0.372	-0.010	-0.001	-0.011	0.003	-0.001
Ireland	1950-51	1960-61	0.344	0.370	0.026	0.063	-0.025	0.003	-0.015
England and Wales	1950-51	1960-61	0.337	0.356	0.019	0.024	-0.009	0.003	0.001
Romania	1952-53	1960-61	0.336	0.350	0.014	0.014	0.012	-0.007	-0.005
Italy	1950-51	1957-58	0.331	0.334	0.004	0.023	-0.006	-0.008	-0.004
Sweden	1950	1960	0.316	0.332	0.016	0.011	-0.002	0.002	0.005
Denmark	1951-52	1956-57	0.300	0.305	0.005	0.012	-0.017	0.004	0.006
Slovakia	1950-51	1960-61	0.294	0.294	0.000	0.000	0.012	-0.008	-0.003
Russia	1950-51	1958-59	0.286	0.268	-0.018	-0.004	0.006	-0.005	-0.015
Hungary	1950-51	1960-61	0.282	0.287	0.005	-0.002	0.003	0.001	0.004
Greece	1950-51	1959-60	0.274	0.273	-0.001	0.019	0.005	-0.013	-0.013
Czech Republic	1950-51	1960-61	0.240	0.241	0.001	0.003	0.012	-0.014	0.000
Slovenia	1950-51	1960-61	0.240	0.243	0.003	0.010	0.000	-0.005	-0.001
Bulgaria	1950-51	1960-61	0.203	0.235	0.032	0.034	0.024	-0.021	-0.004

Note. Countries are sorted in ascending order of *CR* values in 1950-51.
Sources: For European countries: calculations from the ODE (2003) data collection.
For the USA: calculations fertility series by Heuser (1976) updated by W.Kingkade.
For Russia: calculations from the original Goskomstat's statistical tables.

4. International differences in concentration of reproduction among women born around 1960.

Previous section indicated increasing concentration of reproduction as a new trend in changing fertility patterns. Following different paths of demographic development, various countries have arrived to different levels of average fertility and different levels of concentration of reproduction among women.

Table 4 shows average completed fertility, measures of concentration of reproduction, and distributions of women and children by family size for 20 industrialized countries. In addition to the ODE (2003) data collection, we used data from a few other sources for a more complete coverage of the European region. In particular, we used the New Cronos (2001) database of the Eurostat. As we mentioned in section 1, two biggest Western European countries, Germany and France do not have routine registration of births by biological birth order. For these two countries we use distributions of women by number of children they have, estimated by Kreynfeld (2002) and Toulemon (2001).

Table 4 provides two types of distributions: those of women and of children by family size. They represent children's and mother's points of view on the family size. It was shown that the difference between mean family sizes per woman and per child increases when the variance of family size increases (Preston, 1976, Preston, 2003). That is to say that at the same average level of fertility the difference would be greater in a population with greater variability in birth outcomes. For example, average numbers of children per woman are almost equal and very close to 2 in the USA and the Czech Republic. However, USA experience higher concentration of reproduction. Correspondingly, average number of children per woman in the USA is 2.9 vs. only 2.4 in the Czech Republic.

Table 4 shows that the West German women experience the highest level of concentration of reproduction (*CR*=0.43, *Havehalf*=0.26) mostly due to very high childlessness of 24 percent. Proportion of women with one child is as high as 27 percent, while proportions of women with 2+ children are relatively low. West German women experience the lowest average completed fertility of 1.5 children per woman. Although these estimates correspond to age 35, the average and the distribution of women by number of children would not change significantly between ages 35 and 40 (Kreynfeld, 2002).

Relatively high proportions of childless women (16-19 percent), but also relatively high proportions of women with 3+ children (30 to 40 percent) are characteristic for the USA, England and Wales and especially Ireland. Proportions of women with one child and two children in these countries are moderate: 10 to 20 and 30 to 40 percent, respectively. Values of *CR* vary in the Anglo-Saxon countries from 0.36 to 0.37[2], while values of *CF* vary from 2 children per woman in the USA and England and Wales to 2.3 children per woman in Ireland.

The Netherlands do not differ much from the Anglo-Saxon countries. Childlessness in this country is also high (about 19 percent), however proportion of women with 3+ children is lower than in the previous group of countries (25 percent). Therefore, both *CF* and *CR* are somewhat lower than in the Anglo-Saxon countries.

Nordic countries are characterized by moderate to high values of *CF* (from 1.8 to 2.1 children per woman in Denmark and Norway, respectively). These countries (except Denmark) have relatively high proportions of women with 3+ children (28-34 percent). In Norway, Denmark and Sweden childlessness varies from 11 to 16 percent. Finland experiences a higher childlessness of 19 percent. Correspondingly, Finland has a high *CR* of 0.38 *vs*. 0.30 to 0.35 in other Nordic countries. In Finland, as in Anglo-Saxon countries, average level of fertility is supported by relatively high proportion of women with 3+ children counterbalancing the high level of childlessness.

France stands close to Norway with similar distribution of women by family size and very similar values of *CF* and *CR*.

Italy and Spain have high proportions of women with one child (25-26 percent) and also high proportions of women with two children (42-47 percent). Both countries have the same *CF* of about 1.7 children per woman, but Italy has higher *CR* due to greater proportion of women with no children (15 percent *vs*. 11 percent in Spain).

The group of Eastern European countries including Bulgaria, Czech Republic, Slovenia, Russia, and Hungary, have *CF* of 1.8 to 2.0 of children per woman and low *CR*s. Bulgaria, Czech Republic and Slovenia have the lowest levels of *CR* among all countries (0.24). In these countries 35-36 percent of women have half of children. Only 5-7 percent of women remain childless and 53-57 percent of women have two children. In this group of countries a task of population reproduction is shared very evenly among women.

Three remaining countries occupy intermediate positions. Greece has similarities with Spain due to moderate proportions of women with no children and with one child. It also has similarity with the group of Eastern European countries: a high proportion of women with two children. Romania and Slovakia are also close to Eastern European countries, but they have substantially higher proportions of women with 3+ children.

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[2] Calculations from the FFS fertility data reveal also a relatively high *CR* of 0.34 among women born around 1955 in Canada (analysis not shown here).

Table 4. Indicators of average completed fertility, concentration of reproduction and distributions of women by number of children and of children by family size. Cohorts of the late 1950s and the early 1960s in 20 countries.

Country	Cohort	*CF*	*CR*	*Have half*	Proportion of women by number of children*1000					Proportion of children by family size*1000			
					0	1	2	3	4+	1	2	3	4+
West Germany (Source 1)	1960	1.48	0.43	0.26	240	270	340	100	50	183	459	203	155
Finland	1961-62	1.89	0.38	0.27	192	158	357	203	89	84	378	322	217
USA	1960-61	1.98	0.37	0.27	158	193	345	190	114	97	349	288	266
Ireland	1961-62	2.26	0.37	0.28	181	101	291	244	183	45	257	324	374
Netherlands (Source 2)	1960	1.82	0.36	0.28	186	157	412	180	65	85	452	297	166
England and Wales	1955-56	1.98	0.36	0.28	175	127	393	206	99	64	397	312	227
Sweden (Source 2)	1962	1.92	0.35	0.28	159	167	400	182	92	86	418	291	205
Italy	1957-58	1.69	0.34	0.31	148	252	423	137	40	150	502	244	104
Romania	1960-61	2.07	0.33	0.27	90	244	389	140	137	117	376	203	303
France (Source 3)	1960	2.10	0.31	0.30	100	180	400	200	100	86	381	315	218
Denmark	1956-57	1.84	0.31	0.32	126	193	460	171	49	105	500	279	116
Spain	1960-61	1.70	0.30	0.33	119	263	466	120	33	155	548	211	86
Norway (Source 2)	1960	2.09	0.30	0.31	109	146	408	263	74	72	394	378	156
Slovakia	1961-62	2.14	0.29	0.30	98	136	461	207	99	63	430	290	217
Hungary	1961-62	2.01	0.29	0.32	79	205	478	167	72	102	477	250	172
Greece	1959-60	1.90	0.28	0.33	115	155	519	156	54	82	547	246	125
Russia	1958-59	1.86	0.27	0.34	62	268	497	127	46	144	534	205	117
Slovenia	1961-62	1.83	0.24	0.36	60	250	527	134	29	136	575	219	69
Czech Republic	1961-62	1.99	0.24	0.35	68	164	554	165	49	83	558	249	110
Bulgaria	1962-63	1.88	0.24	0.36	52	237	571	100	41	126	609	160	105

Note 1: Countries are sorted in ascending order of *CR*.
Note 2: Estimates for West Germany correspond to fertility completed by age 35.
Sources: For Finland, Ireland, England and Wales, Romania, Italy, Denmark, Spain, Slovakia, Hungary, Greece, Slovenia, Czech Republic and Bulgaria - calculations from the ODE (2003) data collection.
For the USA - calculations from data by Heuser (1976) updated by W.Kingkade.
For Russia - calculations from the original Goskomstat's statistical tables.
Source 1: For West Germany - calculations from data by Kreynfeld (2002).
Source 2: For the Netherlands, Sweden, and Norway - calculations from the Eurostat/New Cronos (2002) database.
Source 3: For France – calculations from data by Toulemon (2001).

There are very close associations between childlessness and *CR* and childlessness and *Havehalf* across countries with Pirson's correlation coefficients of 0.94 and –0.94, respectively.

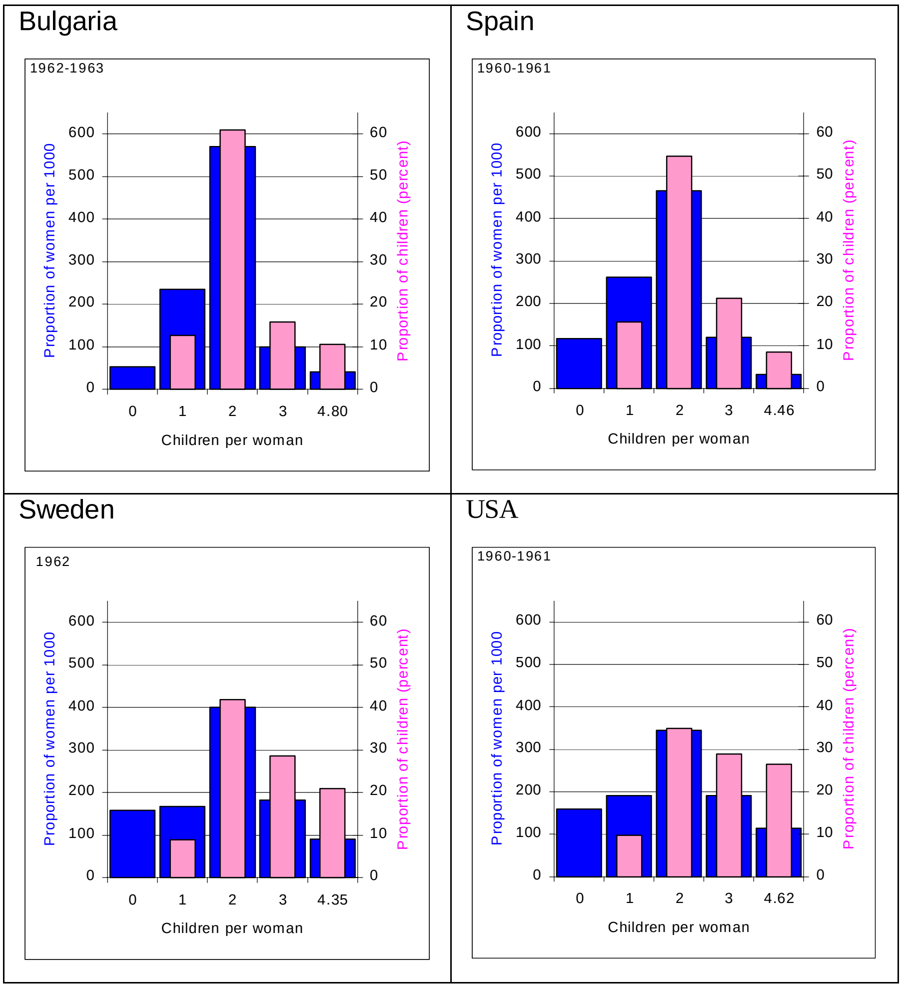

Figure 4. Types of distributions of women by number of children and of children by family size: cohorts of 1960-63 in Bulgaria, Spain, Sweden, and the USA.

Sources: For Bulgaria and Spain: calculations from the ODE (2003) data collection. For Sweden: calculations from the Eurostat/New Cronos (2002) database. For the USA: authors' calculations from data by Heuser (1976) updated by W.Kingkade.

Figure 4 illustrates four types of distributions of women by number of children: the East and the South European, the Nordic, and the Anglo-Saxon.

Finally it is noteworthy that the cohort patterns shown in this section do not reflect the most recent fertility changes. In particular, the do not capture the drastic changes in Eastern European fertility taken place in the 1990s. This issue will be discussed in section 6.2.

5. Exploration into the US pattern of concentration of reproduction with survey micro-data.

Investigation of reasons for relatively high and stable fertility in the USA by Frejka and Kingkade (2001) and Frejka (2004) point at significant fertility differences between socio-demographic groups within the US population. According to these studies, higher fertility among Hispanic and Black women and among women from low education and low income groups supports average level of fertility in the USA.

It is natural to suppose that differences between racial and educational groups in levels of fertility could substantially contribute to the overall inter-individual variability in number of births among women. In addition, analyses of sections 3 and 4 showed that in western countries childlessness is a major component of growing concentration of reproduction. Childlessness, in turn, is correlated with postponement of motherhood, which is associated with high education and professional career (Blossfeld and Huinink, 1991, Lappegård, 2000, Sardon, 2003, UN, 2003).

This section considers influence of education, professional qualification, race, and religion on the concentration of reproduction in the USA using the Current Population Survey of 1998 (CPS, 1998) and the US Family and Fertility Survey of 1995. The latter data set includes more explanatory variables including birth and partnership histories and information about the last occupation for those, who are currently working or who have been working in the past (FFS/USA, 1995, Potter et al., 1997).

Before analyzing survey data we have to make sure that they are compatible with population fertility data considered so far. Appendix 3 compares fertility indicators calculated from the CPS of 1998 and FFS of 1995 with those based on the population data. It appears that the survey-based estimates are slightly biased towards lower numbers of children, but the differences are very minor and produce almost no deviation between the population- and survey-based estimates of *CF* and *CR*.

The Inter-University Consortium on Political and Social Research (ICPSR) provides CPS data on 135 thousand individuals. We analyze only 5,121 women aged 40 to 44. The data contain numbers of children ever born together with mother's race and education. Large number of observations allows estimating indicators of completed fertility for every combination of education and race. Table 5 reveals a wide range of variation of fertility across the race-education groups. The largest group of White non-Hispanic women with a high-school education (25 percent of all women) has 1.9 children per woman on average and is taken as a reference group. The overall average fertility for the whole CPS sample is also 1.9.

Among race-education groups average number of children ever born varies from 3.1 (Hispanic women with less than high school education) to 1.0 (Black women with graduate and professional degrees). The latter value is based on a very small number of observations (0.2 percent of all women) and its deviation from the reference group is not statistically significant. Very low average fertility of 1.3 children per woman is also observed in a much bigger group of White non-Hispanic women with graduate or professional degrees. In general, average fertility tends to be higher among the least educated and the White-Hispanic and the Black women. Importantly, racial differences in fertility virtually disappear among women with college and higher educational levels.

Lower section of Table 5 shows the inter-group differences in average fertility from the concentration perspective. It compares proportions of race-education groups among all women with their proportions among all children. Proportions among children are greater than proportions among women for all women with low education, especially White-Hispanic and Black women. Proportions among children are lower than proportions among women for all levels of education higher than high school. Although, the differentials in fertility rates are very substantial, the general distributions of race-education groups for women and for children do not differ much from each other. This is because proportions of minorities with representing fertility extremes are not large.

Table 5. Educational and racial differences in average fertility. Children ever born, percentages of women and of children for all combinations of education and race: women aged 40-44.

Race	White Non-Hispanic	White-Hispanic	Black	Other	Asian and Pacific	Total
Education	Children ever born					
Less than high school	2.1	3.1	2.8	2.5**	2.6**	2.6
High school (reference)	1.9	2.2	2.1	2.3	2.3	2.0
Some college	1.7	2.0**	1.9**	2.3	2.4**	1.8
Bachalor's degree	1.7	1.4	1.7**	1.1**	1.7**	1.7
Grad/Prof degree	1.3	1.3**	1.1**	1.0**	1.4**	1.3
Total	1.8	2.4	2.0	2.1**	2.0	1.9
	Percentage of 5,121 women / Percentage of 9,612 children					
Less than high school	5.0/5.6	3.6/5.9	1.8/2.7	0.2/0.2	0.5/0.7	11.0/15.1
High school	24.8/25.0	2.3/2.8	4.6/5.2	0.4/0.4	1.3/1.6	33.4/35.0
Some college	21.1/19.6	1.9/2.0	4.3/4.4	0.2/0.3	0.8/1.0	28.4/27.3
Bachelor's degree	14.4/12.9	1.0/0.8	1.7/1.5	0.1/0.0	1.3/1.2	18.5/16.4
Grad/Prof degree	7.0/5.0	0.3/0.2	0.6/0.4	0.1/0.0	0.7/0.5	8.7/6.1
Total	72.3/68.2	9.1/11.6	13.0/14.1	0.9/1.0	4.7/5.1	100.0

Notes: Number of children ever born to White Non-Hispanic women with high school education is taken as a reference category (respective figure is underlined).

** Stays for statistically significant ($p<0.05$) deviations from the reference category.

Source: Calculations from Current Population Survey of 1998 (CPS, 1998).

Measures of concentration of reproduction are especially sensitive to proportions of childless women. Table 6 shows respective odds ratios for educational and racial categories returned by logistic regression[3]. Model 1 shows effects of education and race from the two independent regressions, whereas model 2 shows the equivalent effects with both variables in one regression. Educational effects on childlessness are strong and distributions of all women and of childless women by education seriously differ from each other. In particular, group of completed college and higher levels of education constitutes 27 percent of all women, but 41 percent of childless women. Although odd of childlessness is significantly lowered for White-Hispanic women, this effect becomes statistically insignificant after adjustment for education.

[3] Likelihood ratio tests show that the full-interaction Education*Race model does not significantly ($p<0.05$) differ from a model with independent (additive) effects.

Table 6. Effects of education and race on childlessness. Percentages of groups among all women and among childless women: women aged 40-44.

	Logistic regression odds ratios		Percentage of 5,121 women / Percentage of 978 childless women
	Model 1	Model 2	
Education			
Less than high school	1.1	1.1	11.0/8.0
High school (reference)	1.0	1.0	33.4/24.7
Some college	1.3**	1.3*	28.4/26.3
Bachelor's degree	2.2***	2.2***	18.5/25.3
Grad/Prof degree	3.2***	3.2***	8.7/15.7
Race			
White non-Hispanic (reference)	1.0	1.0	72.3/76.6
White-Hispanic	0.6***	0.8	9.1/6.8
Black	0.8	0.9	13.0/11.6
Other	0.6	0.6	0.9/0.8
Asian and Pacific	0.9	0.8	4.7/4.2

Note: High school education and White non-Hispanic race are taken as a reference category.
* $p<0.1$, ** $p<0.05$ *** $p<0.01$
Model 1: Separate regressions on education and race.
Model 2: Education and race in one regression.
Source: Calculations from the Current Population Survey of 1998 (CPS, 1998).

Table 7 shows to what extent average fertility and concentration of reproduction in the US women depend on racial and educational diversity. The left column displays fertility characteristics for all women. The next three columns show the same indicators for three high-fertility groups: White-Hispanic and Black women, and all women with education lower than high school. The next four columns show fertility characteristics for four low-fertility groups: all White non-Hispanic women and the same women with high school and higher levels of education, with some college and higher levels of education and with college and higher levels of education. It appears that the overall average fertility would be lower by 0.1 if all racial minorities have been excluded and would be lower by 0.2 if, in addition, women with the high school and lower educational levels have been excluded. Such change would bring the US pattern closer to the ones observed in England and Wales and the Netherlands (Table 4). However, one should remember that these two countries also have substantial ethnic minorities and low-education groups.

High percentages (45-50 percent) of White-Hispanic women and of all women with less than high-school education have 3+ children. They also have relatively low childlessness (about 14 percent) and relatively high average fertility of 2.4-2.5 children per women. Among Black women proportion of those with 3+ children is somewhat lower, but is still relatively high (34 percent) and it is combined with lower-than-average childlessness of 17 percent.

White non-Hispanic women experience lower average fertility and higher childlessness (20 percent) and include lower proportion of women with 3+ children. 29 percent of White non-Hispanic women with college and higher levels of education have no children. This advanced group has the highest concentration of reproduction with *CR* of 0.44 and average fertility of 1.5. The lowest *CR* of 0.34 is observed for women with the lowest education whatever the race. This group experiences also the lowest childlessness and the highest average fertility.

Thus, relatively high level of concentration of reproduction in the USA is partly induced by the better-educated fractions of its population. Importantly, concentration of reproduction is high enough in all groups of US women due to somewhat different reasons for different groups. Among the better-educated, high childlessness plays the most important part (Tables 6 and 7). Among the least educated, especially among White-Hispanic and Black women, childlessness is lower, but proportion of women with 3+ children is higher.

Table 7. Distributions of women by number of children, estimates of children ever born and concentration ratio for eight combinations of race with educational level: women aged 40-44.

	All women	White-Hispanic	Black	All races, education <high school	White non-Hispanic	White non-Hispanic, education >= high school	White non-Hispanic, education> high school	White non-Hispanic, education>= college
Number of women	5,121	403	577	523	3,687	3,433	2,171	1,396
Number of children	Percentages							
0	19.1	14.2	17.0	13.7	20.2	20.4	23.9	28.6
1	17.3	13.9	18.8	10.8	17.6	18.0	17.5	15.7
2	35.8	26.5	30.6	28.0	37.9	38.0	36.7	35.6
3	18.2	23.2	19.9	20.8	17.3	17.1	16.1	15.1
4+	9.6	22.2	13.7	27.7	7.0	6.5	5.8	5.0
Children ever born	1.9	2.4	2.0	2.5	1.8	1.8	1.7	1.5
CR	0.39	0.35	0.39	0.34	0.39	0.39	0.41	0.44

Source: Calculations from the US Current Population Survey of 1998 (CPS, 1998).

The FFS data set better provides retrospective information about partnerships and the last professional status of women. Table 8 shows results of logistic regression of childlessness on several variables with and without control for time in partnership (Models 1 and 2, respectively). Time in partnership expresses exposure to risk of conception and is closely correlated with childlessness. At the null level of this variable childlessness equals 78 percent. If time in partnership is 20 years or more, childlessness is as low as 6 percent.

Each of the other variables in the two models has significant univariate associations with childlessness. Childlessness varies from 10 percent among White-Hispanic women to 19 percent among White non-Hispanic women, from 12 percent among women without college education to 28 percent among those with at least 5 years in college, from 12 percent among those, who has never been in the labor force to 25 percent among executive and professional women, from 15-17 percent among the Protestants and Catholics to 25 percent among the Others.

Table 8 shows that many of explanatory variables remain significant in the multivariate regression too. Model 1 returns significant effects for the two upper categories of education and for the White-Hispanic race. This result is similar to the previous ones based on the CPS data. Childlessness is also significantly elevated for all types of professions, except manual workers, compared to “never in the labor force” category. The latter group probably includes many housewives. Finally, there is a significant effect of not belonging to the two main Christian churches.

Model 2 highlights a deeper background of links, revealed by Model 1. It appears that with control for the time in partnership, effects of education become insignificant, effects of race become significant and effects of profession remain as significant as in Model 1. Weakening of effects of education can be explained by a negative correlation between a longer duration of education and a later beginning of family life. Strengthening of the effects of race can be explained by correlation between race and time in partnership. Indeed, mean time in partnership is about 17 years for White non-Hispanic women, 16 years for White-Hispanic women and only 12 years for Black women.

Noteworthy, effects of profession remain significant even with control on the time in partnership. It means that professional activity is a factor of childlessness even within partnership. Smooth gradient in odds ratios across professional categories suggests that these effects are related to professional activities themselves and not only to a simple contrast between those working and those staying at home. This result agrees with Hoem and colleagues (2003), who found that type of education connected with type professional career to be even more important for childlessness than the level of education.

Table 8. Effects of race, time in education, occupation, religion, and time in partnership on childlessness: women aged 40-44.

Variable	Value	Odds ratio	
		Model l	Model 2
Race	White (ref)	1.00	1.00
	Black	0.91	0.31***
	White-Hispanic	0.59**	0.37***
	Other	0.89	0.52
Time in studying	No college (ref)	1.00	1.00
	0 - 4.9 years	1.49**	1.16
	5+ years	1.85***	1.19
Last profession	Never in the LF (ref)	1.00	1.00
	Executive and Professional	1.98***	1.91***
	Technical and Sales	1.60*	1.78**
	Clerical	1.73**	1.58*
	Services	1.57*	1.55
	Manual	1.27	1.03
Religion	Protestant (ref)	1.00	1.00
	Catholic	1.18	0.95
	Other	1.80***	1.43*
Time in partnership	Never in partnership (ref)	-	1.00
	1-9 years	-	0.19***
	10-14 years	-	0.05***
	15-19 years	-	0.04***
	20+ years	-	0.02***

Notes: * p<0.1, ** p<0.05 *** p<0.01
Source: Calculations from the Family and Fertility Survey of 1995 (FFS/USA, 1995).

Effect of religion is relatively weak. Additional tabulations (not shown here) tell that belonging to the Protestant church is associated with lower risk of childlessness only among better educated and better qualified women and does not make difference in lower-level groups.

Table 9 displays a greater number of women's sub-groups and a wider range of variation of average fertility and concentration of reproduction compared to table 8. The highest *CR* is observed among executive and professional women with a non-Protestant religion. Childlessness in this relatively small group is about 33 percent, average number of children per woman is only 1.3, while *CR* is 0.49. It means that 23 percent of women of this group have half of children. The lowest *CR*s of 0.30 is observed in the group of Black and White-Hispanic women, who have never been in labor force with no college education. 31 percent of these women have half of children. They have 3 children per woman on average and less than 5 percent of them have no children.

Table 9 demonstrates a spectacular range of fertility regimes. The best educated and highly qualified groups of White non-Hispanic women experience high childlessness, low average fertility and high concentration of reproduction. This pattern is comparable to West German cohorts born around 1960 (Table 4), but the US group has even higher childlessness and lower average fertility. Among these women a degree of diversity in childbearing is especially high since about half of them have no more than one child, whereas another half has 2+ children.

The least educated and qualified groups experience fertility patterns comparable to those observed in the US baby boom cohorts of the 1930s. They have very high average fertility and relatively low concentration of reproduction. However, even in these groups *CR* is not low by the European standard. Diversity among women in these groups depends on the contrast between women having less than 2 children with high proportions of women with 3+ children.

Table 9. Percentages of women aged 40-44 by number of children, estimates of children ever born, concentration ratio, and *Havehalf* for 13 combinations of race, education, occupational status, and religion.

Race	Education	Occupation	Religion	*n*	0	1	2	3	4+	Children ever born	*CR*	*Havehalf*
B&W-Hisp	No college	Never in LF	All	127	4.7	14.4	21.9	26.4	32.6	3.0	0.30	0.31
B&W-Hisp	No college	Manual& Never in LF	All	197	5.8	17.5	20.7	22.8	33.2	3.0	0.32	0.31
All	No college	Manual& Never in LF	All	379	11.3	14.7	31.5	20.7	21.7	2.4	0.35	0.30
All	No college	All	All	866	12.3	16.1	35.8	21.2	14.8	2.2	0.34	0.29
All	All	Manual& Never in LF	All	591	12.5	17.1	33.6	19.4	17.5	2.2	0.35	0.28
B&W-Hisp	All	All	All	634	15.1	18.1	28	21.2	14.8	2.1	0.34	0.29
All	All	All	All	1,808	17.9	17.3	36.1	18.4	10.3	1.9	0.38	0.27
White/nHisp	All	All	All	1,174	18.9	17.0	38.7	17.9	7.5	1.8	0.37	0.27
All	College+5	All	All	295	28.3	20.6	33.1	14.3	3.7	1.5	0.45	0.25
All	All	Exec&Prof	All	213	29.5	22.1	32.9	12.2	3.3	1.4	0.46	0.25
All	College+5	Exec&Prof	All	204	29.7	22.1	32.6	12.2	3.4	1.4	0.46	0.24
White/nHisp	College+5	Exec&Prof	All	154	29.8	23.2	33.0	10.6	3.4	1.4	0.46	0.24
White/nHisp	College+5	Exec&Prof	Non-Protestant	103	32.5	22.8	29.3	11.5	3.9	1.3	0.49	0.23

Notes: "Whie/nHisp" stays for White non-Hispanic; "College+5" stays for five or more years of college/university; "Exec&Prof" stays for executive and professional positions; "B&WHisp" stays for Black and White-Hispanic.
Source: calculations from the US Family and Fertility Survey of 1995 (FFS/USA, 1995).

6. Summary of findings and discussion

6.1. *Analyses and findings.*

The present study documents increasing concentration of reproduction and analyzes components of this change. For measurement, we used concentration ratio, known also as Gini coefficient, as well as *Havehalf* and *Halfhave* percentile measures of inter-individual variability. In principle, increases in proportions of women with lower-than-average or higher-than-average numbers of children produce increases in concentration of reproduction. *CR* and the half-statistics are especially sensitive to childlessness (e.g. existence of women, who do not contribute to the reproduction at all) and (to a lesser extent) to proportions of women with 4+ children.

Vaupel and Goodwin (1987) found a declining trend in concentration of reproduction in the USA from cohorts born in the beginning of the 20th century to cohorts of the early 1930s. We extended this analysis to younger cohorts for the USA as well as for other industrialized countries and found that in majority of countries inter-individual differences in fertility have begun to increase from older to younger cohorts. The increase started from cohorts of the mid-1930s in the USA and cohorts of the mid- or late 1940s in Western Europe. In Eastern Europe the change was less pronounced and began in cohorts of the 1950s. Thus, population reproduction becomes more unevenly distributed among women and their smaller proportions produce greater proportions of children.

Comparison of trends in concentration of reproduction for all women with the equivalent trends for mothers suggest that growing childlessness is the greatest contributor to the general increase in western countries. Decompositions of temporal changes in concentration of reproduction by birth order confirm it. In addition, in some countries, especially in countries of Eastern Europe increases in proportions of women with one child and decreases in proportion of women with two children produced positive contributions to concentration of reproduction. Finally, in many western and eastern countries numbers of women with 3+ children have decreased producing small negative contributions to concentration of reproduction.

In majority of countries concentration of reproduction increases along with a decline in average fertility. In some countries, however, average fertility is relatively stable since substantial proportions of women with 3+ children counterbalance childlessness. Interestingly, these are either social welfare countries with advanced family policies such as Norway or Finland (Gauthier, 2002) or more market-oriented societies such as the USA, where market probably provides alternative opportunities for supporting maternity and childcare (Schoen, 2001, Morgan, 2003a).

Cohorts born around 1960 in 20 countries of Europe and in the USA had *CR*s varying from 0.24 to 0.43. In countries with low concentration of reproduction about 35 percent of women had half of children, in countries with high concentration of reproduction only 26-28 percent of women had half of children. The highest concentration of reproduction was observed in West Germany; where almost quarter of women had no children. Relatively high concentration of reproduction was also observed in the USA, and other Anglo-Saxon countries, where high childlessness coincided with relatively high proportions of women with 3+ children. In Norway, and France proportions of women 3+ were also relatively high. Finland had the highest concentration of reproduction compared to Scandinavian countries due to its higher childlessness. Italy, Spain, and Greece had high proportions of women with two children. Among these countries, Italy had the highest concentration of reproduction. Most countries in Eastern Europe had low concentrations of reproduction. These countries were characterized by high proportions of women with two children or one child and very low childlessness. Bulgaria experienced the lowest concentration of reproduction among all countries under consideration. Almost 60 percent of women in this country had two children, only 5 percent of women were childless and only 4 percent of women had 4+ children.

Data of the US Current Population Survey of 1998 and the US Family and Fertility Survey of 1995 were used for decomposition of inter-individual inequality in fertility among American women aged 40 to 44. Patterns of fertility strongly vary across educational, professional and racial groups. Advanced groups of US women experience high childlessness of about 30 percent, low average fertility of 1.3-1.5 children per woman and high *CR*s of 0.45-0.49 telling about great amount of inter-individual diversity within these groups. At the same time, groups with lower levels of education and qualification experience relatively low childlessness of about 10 percent, high average fertility of 2.4-3.0 children per woman and relatively low *CR*s of 0.30-0.35. Education is a strong determinant of childlessness due to postponement of stable partnership and childbearing, while professional activity increases risk of childlessness even in partnership. Influence of education on childlessness is mostly related to its connection to time in partnership, whereas professional activities increase risk of childlessness even in partnership.

One might think that high concentration of reproduction among US women can be attributed to fertility contrasts between the socio-demographic groups. Our analysis shows, however, that education and race can explain only part of the overall diversity and that concentration of reproduction is high enough within each socio-demographic group.

6.2. *Data limitations and what could be a direction of the current trend.*

Our analyses largely rely on the ODE data on cohort fertility by age and parity and similar data for Russia, Sweden, and the USA. In addition, for the cohorts born around 1960 with completed or almost completed fertility we used a few other sources of information. For a more detailed analyses of patterns of concentration of reproduction in the USA, we used retrospective survey data on women with completed fertility.

All these data are looking at the past and do not show the recent changes. Therefore, one could wonder whether concentration of reproduction continues to increase in younger cohorts. Although it is impossible to answer this question precisely, an affirmative answer is likely. Indeed, in most western countries the increase in concentration of reproduction was fueled by rising childlessness. There are already estimates telling that childlessness is likely to rise further across cohorts of 1962-67 cohorts in most of the West European countries (Sardon, 2002, Sardon, 2003, UN, 2003, Frejka and Sardon, 2003). In West Germany, England and Wales, Austria, Italy, Finland, and Ireland it has could exceed 20 percent in cohorts of the mid-1960s and it could come very close to 20 percent in the Netherlands and Greece (Sardon, 2002). Childlessness could be also increasing in several Eastern and Central European countries such as Hungary, Czech Republic, Slovakia, and Slovenia (Sardon, 2002). The situation is less clear in the USA, where childlessness seems to level off near 16 percent in cohorts born between 1960 and 1965 (Sardon, 2002, Sardon, 2003). Postponement of motherhood spreads and it increases the risk of childlessness (Toulemon, 1996, Steehof and De Jong, 2001). So, the increasing trend in childlessness and an induced increase in concentration of reproduction could be continuing.

Most recent changes in fertility have probably modified some of the regional types of distributions by family size described in section 4. Most importantly, in several countries of Central and Eastern Europe such as Czech Republic, Hungary, and Slovenia birth schedules were intensively transforming in the 1990s towards western pattern of a wide-spread postponement of births (Sobotka, 2003). It has potential to rise of inter-individual variability in fertility and an increase in concentration of reproduction in cohorts born in the late 1960s and the 1970s.

On the other hand, Russia and other post-Soviet countries, as well as Bulgaria and Romania also experienced dramatic falls in intensity of birth over the 1990s, but much less changes in its timing and only very minor increases in childlessness (Sardon, 2002, Sobotka, 2003). Consequently, a relatively small increase in concentration of reproduction can be expected in cohorts of the 1960s-70s due to some growth of childlessness and decreases in proportions of women with two children and increases in proportions of women with one child.

6.3. *Towards understanding of the phenomenon.*

Existing theories justify roles of different sets of factors for the main vector of fertility decline. Links between fertility change and economic conditions (Easterlin, 1976, Becker, 1981, Kohler and Kohler, 2002), women's rising employment and changing economic positions of women and men (Oppenheimer, 1994), values, norms and ideational change (Lesthaege, 1995), and institutional/welfare regimes (Espig-Andersen, 1999) are well established. None of these theories, however, specifically addresses inter-individual diversity in fertility and its concentration in certain categories of women. Indeed, our question of interest is not why an average woman has more or less children, but why fertility behaviors differ so much among women.

In this connection, the "preference theory" by Hakim (2000, 2003) has an important advantage for understanding of empirical results of the present study since it is primarily focused on inter-individual differences in women's orientation toward family *vs.* work and career. Hakim claims that the contraceptive revolution and the equal opportunity revolution lead to increasing control by women over their own fertility and to increasing influence of women's lifestyle preferences on family size. She schematically splits women into three groups: work-centered, adaptive, and home-centered representing 20, 60, and 20 percent of the whole population, respectively. The work-centered group tends to adjust fertility behavior to career plans. The adaptive group prefers to combine employment and family work without giving a fixed priority to either. Home-centered women devote themselves to family and children and often avoid paid work if there is no economic necessity. Hakim claims that fertility is twice higher among home-centered women than among work-centered women (Hakim, 2003).

According to Hakim, the preference divide runs largely across educational and socio-occupational categories defining an unobserved determinant of fertility behavior. Although, highly educated women constitute a greater part among the work-centered group, the correlation between preferences and socio-occupational group is not overwhelmingly strong. Hakim found that relative difference in number of young children in household between preference groups to be greater among women with high education.

In general, results of the present study and especially its section 5 based on micro-data of the two US surveys, agree with what could be expected from the preference theory. In particular, we found that only a moderate part of variability in fertility across women can be attributed to education, profession, race and religion and that polarization of childbearing is most pronounced among highly educated women (see also Hakim, 2003, p.362-366).

It is not clear which factors determine preferences themselves. They could depend on cultural backgrounds, conditions of socialization and some other socio-psychological factors. Bio-genetic factors could take part in determining preferences (Rodgers et al., 2003). Women's preferences and their role for polarization of family and fertility behaviors deserve further empirical studies. These studies should be based on micro-data from prospective observation of women's behaviors and orientations over time. Assessing of preferences from retrospective data is problematic due to possible reverse connection between past experiences with children, family, education and work and the current preferences. Panel or longitudinal cohort surveys would help to understand how preferences, their changes over time and their distribution among women are linked to norms and values, changing economic and employment situations, and opportunities provided by state family policies. Statistical analysis of such data could link various sequences of births with explanatory variables including some preference variables and their distributions across person-years.

6.4. *Implications and a look into the future.*

Increasing variability in fertility can lead to increases in other types of inter-individual inequalities. For example, distribution of social capital across the population would become more unequal. In the future, aging generations of today's parents will be receiving increasingly uneven economic and psychological support from children (Wolf, 1999, Couch et al., 1999, Wolf et al., 1997). In the coming decade one could expect growing proportions of children to be born to disadvantaged families or certain changes in ethno-cultural structure of the population.

At a first glance, the latter perspective looks inevitable since women with low education and qualification, experience higher fertility. In fact, it can or can not be the case depending on future changes in inter-group fertility differentials, educational and professional structures of population and migration flows. It is clear, for example, that rapid expansion of high education of women can outweigh relatively low fertility among such women. Indeed, period statistics of the USA tell that proportion of births to mothers, who spent 16+ years at schooling actually increased from 14 percent in 1980 to 25 percent in 2000 (Lichter and Wooton, 2004). In respect to race, the situation is somewhat different since proportion of births to Hispanic mothers increased from 9 to 20 percent.

The present increase in concentration of reproduction in most countries is largely driven by contrast between increasing numbers of childless women and women with children, majority of whom have two children. High education and professional career lead to birth postponement due to normative expectations that young women who attend school are not at risk of entering marriage and later on due to a conflict between accumulation of career resources and motherhood (Blossfeld and Huinink, 1991). Analyses of INSEE Family Surveys data by Toulemon (1996) showed that only four percent of couples with women born in the 1930s-early 1950s in France deliberately did not want to have children. The author attributes increasing childlessness in younger French cohorts of the 1950s-60s to widespread postponement of parenthood to ages over 30 or even 35, at which risk of infecundity becomes high.

In the future more and more women will be graduated from universities and colleges and enter demanding and time consuming jobs (Lehto and Sutela, 1999). If highly educated and motivated women target high-level careers and *want to be as successful as the successful men are*, they are unlikely to give many births and many of them could remain childless[4]. If the present patterns of childbearing in the advanced groups of women do not change, further expansion of education and

[4] Impressive descriptions of challenges faced by high-career women can be found in the book by Hewlett (2003).

highly qualified professions among women will lead to further increase in childlessness and concentration of reproduction.

On the other hand, section 5 suggests that there are certain forces making fertility highly variable within the advanced groups. So, a change in women's distribution within the advanced groups is possible. An increase in the size of the group makes it less selective and could be accompanied by lowering of percentage of the career-oriented women. For example, a study of trends in Norwegian fertility revealed some decrease in childlessness of women with university education has decreased from cohorts of the early 1940s to cohorts of the 1950s (Lappegård, 2000).

Concentration of reproduction implies uneven contributions to the overall production of offspring by various fractions of population. If concentration of reproduction continue growing, production of children could become a matter of specialization. In order to support the overall production of children, a shrinking part of women will have to give more and more births. Indeed, the US cohort of 1960 had about two children per woman on average herewith 16 percent of women were childless, while remaining 84 percent of women had 2.3 children on average (Table 7). If proportion of childless women increases to 25 or 30 percent, then remaining 75 or 70 percent of women should give 2.6 or 2.8 births on average, respectively, to preserve the same average level of fertility.

The latter figures suggest that future family policies should focus not only on the majority of "working mothers", but also specially on helping women with a higher chance of childlessness and on supporting those "family-centered", who would be willing to devote more of their lifetime to family and to have more children, but can not afford it. Many women from the latter group have to combine a full-time work with rearing children due to economic necessity and have no opportunity for long-term departures from their jobs. In this connection, child home care allowance policies introduced in Finland and Norway in the 1980s-1990s are probably a step in desirable direction. These measures enable long-term paid leaves of women from their jobs for taking care of children until they are aged three (Hilamo, 2002, Gauthier, 2002). It seems that these policies have produced a positive impact on progression to second and third births at least in Finland (Ruokolainen and Notkola, 2002, Vikat, 2004).

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Appendix 1. Calculation of parity progression tables and distributions of women and children by parity.

The calculation begins from matrix $\|f_{x,i}\|$ of the cohort fertility rates by age of mother and parity offset for the whole female population

$$f_{x,i} = \frac{B_{x,i}}{(P_{x,i} + P_{x+1,i})/2},$$

where age x varies within the range of reproductive ages [w, W] and the birth order i varies between 1 and the I+1. In the present study w=15, W=39 or 44 in some calculations, I=4+ and I+1=5[5]. Country-specific matrices of fertility rates for parities 1, 2, ..., 5 are taken from the ODE/MPIDR collection of data on cohort fertility in Europe.

On this basis the following set of fertility indicators has to be computed.

1. Average age of mother at i-th birth $\overline{X}_i$:

$$\overline{X}_i = 0.5 + \sum_{x=w}^{W}(f_{x,i} \cdot x) / \sum_{x=w}^{W} f_{x,i} .$$

2. The tabular population of women by age and parity $l_{x,i}$:

$$l_{w,0} = 1000 \;,\; l_{w,i} = 0, i \ge 1,$$

$$l_{x,0} = l_{x-1,0} - f_{x-1,1}, w+1 \le x \le W,$$

$$l_{x,i} = l_{x-1,i} + f_{x-1,i-1} - f_{x-1,i}, w+1 \le x \le W, 2 \le i \le I-1,$$

$$l_{x,I} = l_{x-1,I} + f_{x-1,I}, w+1 \le x \le W .$$

3. The parity progression ratios a_i:

$$a_i = (\sum_{j=i}^{I} l_{W,j}) / (\sum_{j=i-1}^{I} l_{W,j}),\; 1 \le i \le I .$$

4. Completed fertility CF_i:

$$CF_i = l_{w,0} \cdot (a_1 + a_1 a_2 + ... + a_1 a_2 a_3 ... a_I) .$$

5. The average number of births for the last birth order I (4+) per woman:

$$b_{0,I} = 0 ;$$

$$b_{x,I} = \sum_{y=0}^{x-1} f_{y,I+1} .$$

6. Number of children born by mothers $C_{x,i}$:

$$C_{x,i} = l_{x,i} \cdot i, \quad i=0,1,...,I-1;$$

$$C_{x,I} = b_{x,I} + (I-1) .$$

[5] We use fertility data for birth orders from 0 to 5 for having birth order 4+ as the last open-ended category in the parity progression table.

Appendix 2. Comparison of between indicators calculated for the range of ages 15-39 and 15-44 for four countries and five birth cohorts.

Year of birth	Bulgaria		England and Wales		USA	
	15-39	15-44	15-39	15-44	15-39	15-44
Completed fertility *CF*						
1921-1922*	-	-	2.0	2.0	2.7	2.8
1931-1932	2.1	2.1	2.3	2.3	3.2	3.2
1941-1942	2.1	2.1	2.3	2.3	2.5	2.6
1951-1952	2.0	2.1	2.0	-	2.0	2.0
1961-1962**	1.9	-	-	-	2.0	-
Average age of mother						
1921-1922*	-	-	28.0	28.4	28.0	28.5
1931-1932	25.3	25.4	27.5	27.7	26.7	26.9
1941-1942	24.7	24.8	25.8	26.0	25.5	25.7
1951-1952	24.4	24.5	26.4	-	26.8	27.2
1961-1962**	24.0	-	-	-	27.5	-
Proportion of women having half of children *Havehalf*						
1921-1922*	-	-	0.24	0.24	0.25	0.25
1931-1932	0.31	0.31	0.26	0.26	0.30	0.30
1941-1942	0.36	0.35	0.30	0.30	0.28	0.28
1951-1952	0.37	0.37	0.28	-	0.26	0.27
1961-1962**	0.37	-	-	-	0.27	-
Proportion of children born by half of women *Halfhave*						
1921-1922*	-	-	0.80	0.80	0.78	0.78
1931-1932	0.69	0.69	0.76	0.76	0.75	0.75
1941-1942	0.64	0.64	0.71	0.71	0.74	0.74
1951-1952	0.63	0.63	0.72	-	0.76	0.76
1961-1962**	0.64	-	-	-	0.75	-
Concentration ratio (or Gini coefficient) *CR*						
1921-1922*	-	-	0.43	0.43	0.38	0.38
1931-1932	0.30	0.30	0.38	0.38	0.32	0.32
1941-1942	0.23	0.23	0.32	0.32	0.34	0.34
1951-1952	0.21	0.21	0.34	-	0.38	0.38
1961-1962**	0.22	-	-	-	0.37	-
Average inter-individual difference in the number of children = *CR*CF*						
1921-1922*	-	-	0.84	0.87	1.02	1.05
1931-1932	0.63	0.63	0.87	0.88	1.02	1.03
1941-1942	0.48	0.48	0.72	0.73	0.86	0.86
1951-1952	0.43	0.43	0.69	-	0.74	0.75
1961-1962**	0.43	-	-	-	0.74	-

* 1925-1926 for Finland

** 1960-1961 for the USA

Appendix 3. Comparison of survey and population data: distributions of the US women aged 40-44 by number of children, measures of average completed fertility and concentration of reproduction.

Number of children	Survey data		Population data	
	FFS, 1995 Cohort of 1950-55, n=1808	CPS, 1998 Cohort of 1953-58, n=5121	Cohort of 1950-55	Cohort of 1953-58
0	17.9	19.1	17.4	17.7
1	17.3	17.3	17.9	17.8
2	36.1	35.8	34.9	34.2
3	18.4	18.2	18.6	19.2
4+	10.3	9.6	11.2	11.0
CF (or children ever born for survey data)	1.9	1.9	2.0	2.0
CR	0.38	0.39	0.38	0.38

Sources: Authors' calculations from the population data by Heuser (1976) assembled and updated by W.Kingkade, the Family and Fertility Survey of 1995 (FFS/USA, 1995) and Current Population Survey of 1998 (CPS, 1998).